



CERES FLASHFlux Status:

Near-Real Time Surface Radiative Fluxes and Meteorology for Research and Applications

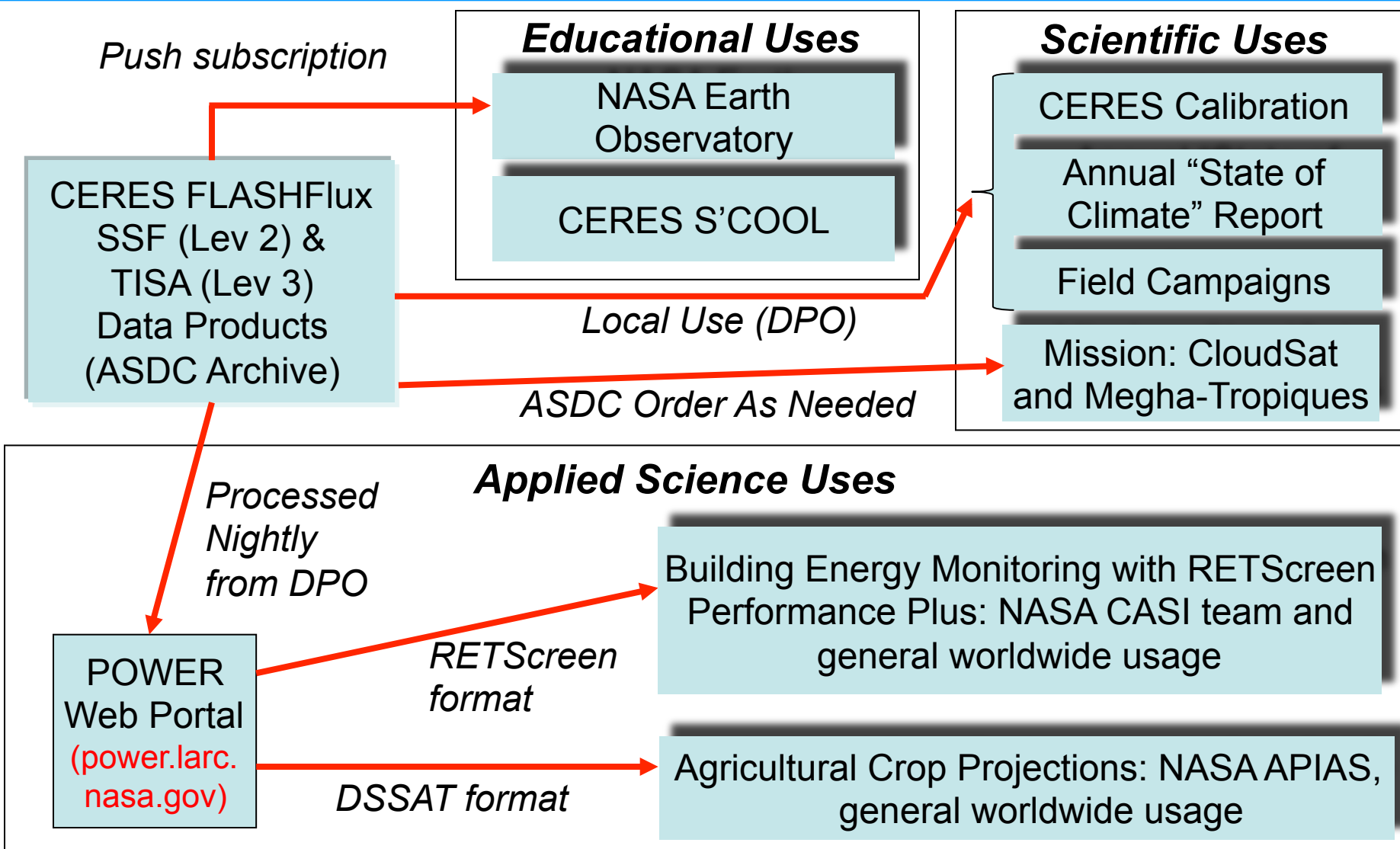
*Paul Stackhouse, David P. Kratz, and Takmeng
Wong, (NASA LaRC)*

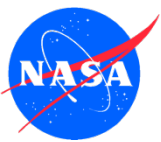
*PC Sawaengphokhai, Shashi Gupta and Anne
Wilber (SSAI)*

*Tonya Davenport, Lindsay Parker and the
Atmospheric Science Data Center Team (SSAI)*



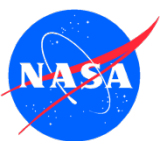
FLASHFLUX: Schematic of Current Uses






FLASHFlux Status

- ***Continuing production with v3B (since August 2015)***
 - FLASHFlux SSF available via CERES subsetter and ASDC
 - FLASHFlux TISA available from ASDC and specialized formats through POWER web portal (power.larc.nasa.gov)
- ***Version 3B Validation***
 - Processed and compared to latest BSRN/Buoy measurements (WHOI)
- ***Growing Applied Science Usage***
 - Daily fluxes released through POWER web site as ASCII time series
 - Agricultural and Energy usage growing (1000+ users, 180,000 orders per, 16 GB per month)
- ***ARISE Support***
 - Using CERES subsetter, created daily archive of FLASHFlux SSF for the Beaufort Sea area; added daily averaged fluxes from TISA
 - Plan to compare to climate quality data products
- ***Contributions of 2014 “State of Climate”***




FLASHFlux: Ordering from CERES Subsetter




National Aeronautics and Space Administration

SEARCH CERES









Home: CERES
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CMIP5 CERES Data
Science Team Members
Documentation
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CERES Data Products

To subset, visually browse, and download CERES data products in netCDF format, click "Browse & Subset". For more information and documentation on a specific product, click on the "Data Product" name. Or as a quick reference, click on the  icon.

Access to the complete CERES archived HDF data products, [HDF Products](#)

Level 3B: Spatially (regional, global, etc.) and temporally (daily, monthly, etc) averaged fluxes where the net flux has been energy balanced.

Data Product (Information & Documentation)	Description	Parameter	Resolution	Version/Availability	Order Data
EBAF-TOA	Monthly and climatological averages of TOA clear-sky (spatially complete) fluxes, all-sky fluxes, and cloud radiative effect (CRE), where the TOA net flux is constrained to the ocean heat storage . Data Quality Summary				Browse & Subset
EBAF-Surface	Monthly and climatological averages of computed surface clear-sky fluxes, all-sky fluxes, and cloud radiative effect (CRE), consistent with the CERES EBAF-TOA fluxes. Data Quality Summary				Browse & Subset

Level 3: Spatially (regional, global, etc.) and temporally (daily, monthly, etc) averaged fluxes and clouds.







Data Product (Information & Documentation)	Description	Parameter	Resolution	Version/Availability	Order Data
CERES geostationary (GEO) enhanced	temporally				

CERES FLASH_SSF Subsetting and Browsing

[Data Products Page](#) | [Change Password](#) | [Help](#)

Selection Page [My Orders](#)

Parameters


<input type="checkbox"/> Time/Location /Angles	 Click to select individual parameters
<input checked="" type="checkbox"/> CERES Observed TOA Fluxes and Radiances	 Selected Fields: Click to View
<input checked="" type="checkbox"/> Surface Fluxes	 Selected Fields: Click to View
<input checked="" type="checkbox"/> Surface Parameters	 Selected Fields: Click to View
<input checked="" type="checkbox"/> GEOS-5 Atmosphere Parameters	 Selected Fields: Click to View
<input checked="" type="checkbox"/> Cloudy Footprint Area	 Selected Fields: Click to View

Spatial Resolution

☒ Footprint (20 km nominal)

West

0



360

East

North

90

-90

South

Satellite

☐ TERRA (12/ 01/2014 - (05/01/2015) [List of missing dates](#)

☒ AQUA (12/ 01/2014 - (05/01/2015) [List of missing dates](#)

Time Range

Available Time Range: 12/1/2014 to 5/1/2015.

From: - - (MM-DD-YYYY) To: - - (MM-DD-YYYY)

Level 2: CERES instantaneous footprint level (20km)

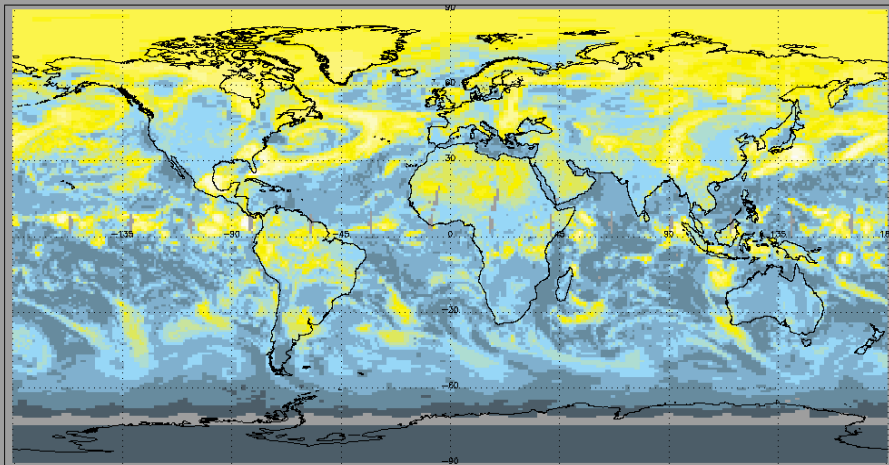
Data Product (Information & Documentation)	Description
SSF	CERES observed TOA fluxes, MODIS cloud and parameterized surface fluxes. Terra Data Quality Summary Aqua Data Quality Summary
FLASH_SSF	Near real-time CERES fluxes and cloud. Not of climate quality or to be appended to CERES dataset.

Note: The Browse & Subset ordering tool will query



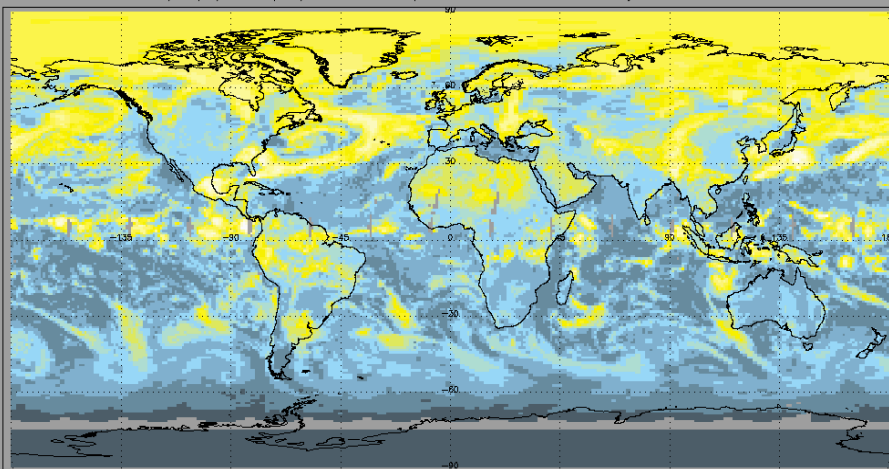
Recent Examples: TISA 4/29/15

Daily Avg, Tot-Sky, TOA SW Flux (Daily Average TOA Flux Total-Sky) Data Range: 1: 1; 1; 1; 1; 1; 180; 1; 1; 360; 1
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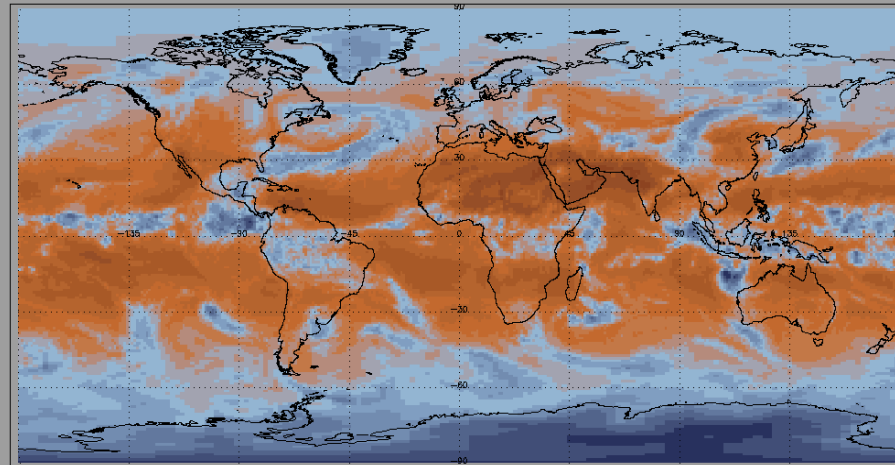
No Data 0 22 44 66 88 110 132 154 177 199 221 243 265 287 309 332
Watts per square meter

Daily Avg, Tot-Sky, TOA SW Flux (Daily Average TOA Flux Total-Sky) Data Range: 1: 1; 1; 1; 1; 1; 180; 1; 1; 360; 1
/data/FF/Version3B/TISA/FLASH_TISA_Terra+Aqua_Version3B_113022.20150429 Mon May 4 13:30:50 2015



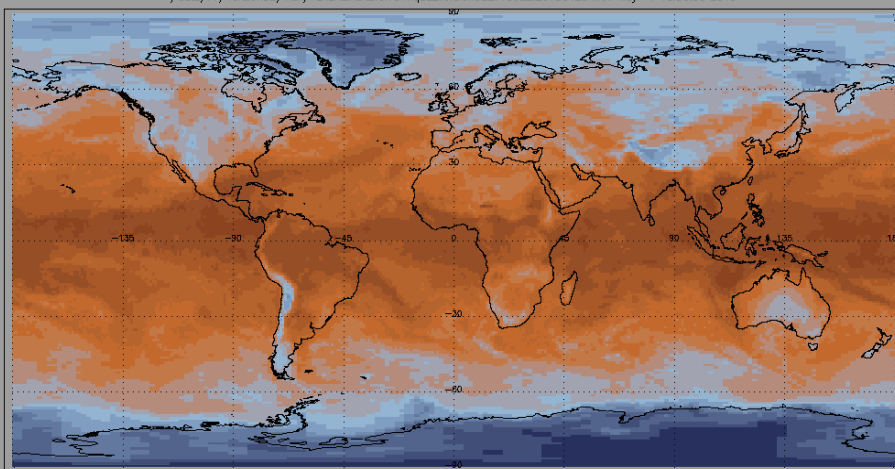
No Data 0 22 44 66 88 110 132 154 177 199 221 243 265 287 309 332
Watts per square meter

Daily Avg, Tot-Sky, TOA LW Flux (Daily Average TOA Flux Total-Sky) Data Range: 1: 1; 1; 1; 1; 1; 180; 1; 1; 360; 1
/data/FF/Version3B/TISA/FLASH_TISA_Terra+Aqua_Version3B_113022.20150429 Mon May 4 13:29:42 2015



No Data 94 110 126 143 159 176 192 209 225 242 258 275 291 308 324 341
Watts per square meter

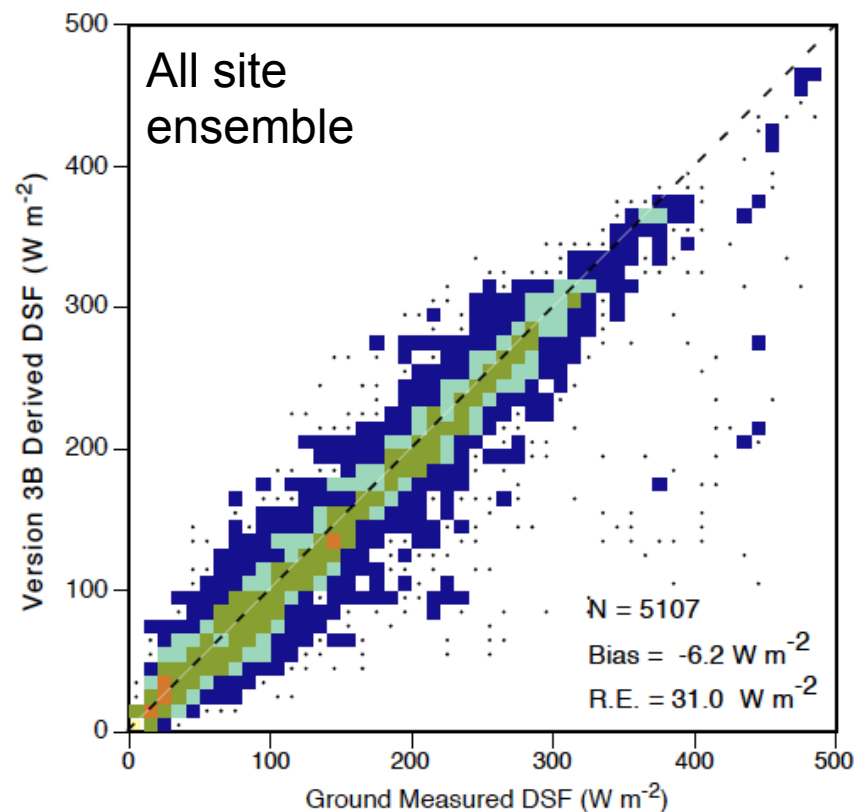
Daily Avg, Tot-Sky, TOA LW Flux (Daily Average TOA Flux Total-Sky) Data Range: 1: 1; 1; 1; 1; 1; 180; 1; 1; 360; 1
/data/FF/Version3B/TISA/FLASH_TISA_Terra+Aqua_Version3B_113022.20150429 Mon May 4 13:30:06 2015



No Data 70 96 123 149 176 203 229 256 282 309 336 362 389 415 442 469
Watts per square meter



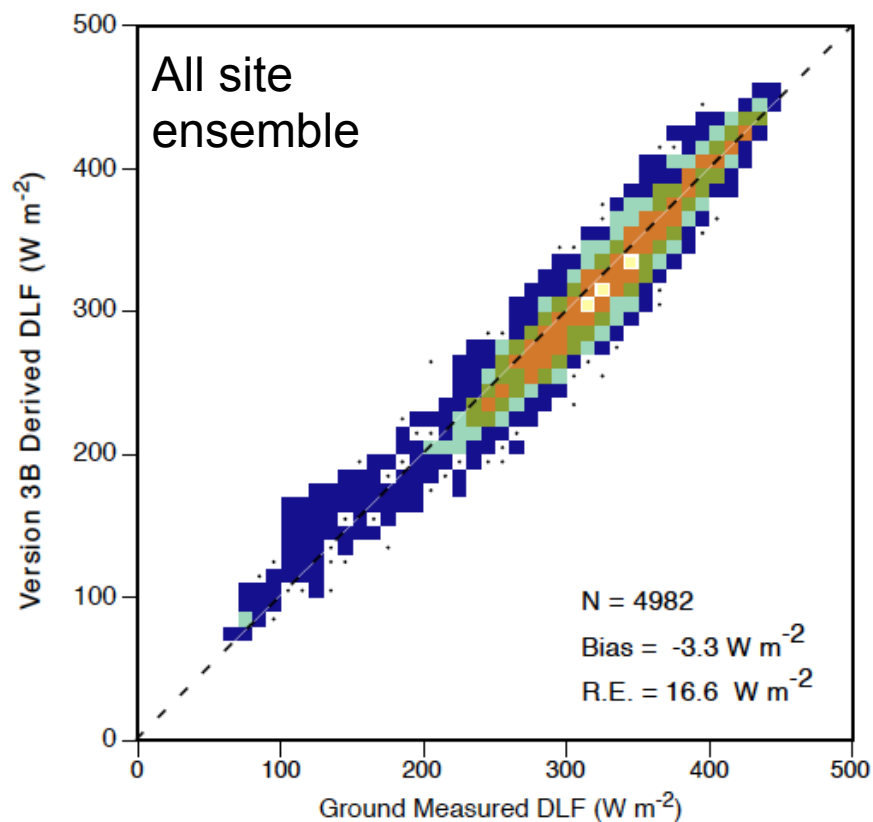
Recent SW Validation: 8/2014 – 2/2015



Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	-6.2	31.0	5107
Continental	-5.4	28.0	2494
Coastal	-2.2	19.2	1514
Desert	-2.1	17.5	636
High Latitude	-65.6	73.	210
Island	0.8	26.8	173



Recent LW Validation: 8/2014 –2/2015



Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	-3.3	16.0	4982
Continental	-6.9	17.6	2342
Coastal	-1.0	12.4	1484
Desert	-3.3	12.9	629
High Latitude	12.0	17.8	296
Island	2.9	8.0	151
Buoy (WHOI Bay of Bengal)	-10.7	10.0	80

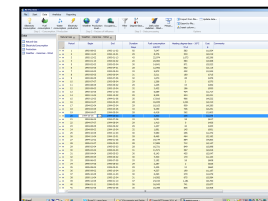
Applied Science Uses: Energy

RETScreen Plus - Performance Analysis Module

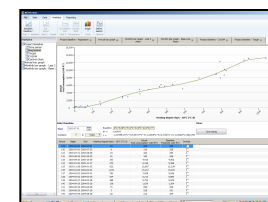
RETSCREEN® INTERNATIONAL

www.etscreen.net

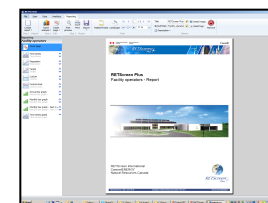
- Helps user monitor, analyse, and report key energy performance data to facility operators, managers and senior decision-makers
- Energy management software tool
 - Monitoring, Targeting & Reporting (MT&R)
 - Measurement & Verification (M&V)
 - Energy tracking
- Integrates near-real-time NASA -derived solar satellite (CERES FLASHFlux) and weather data (GMAO FP-IT) for entire surface of planet



Data



Analytics



Reporting

CanmetENERGY

Leadership in ecoInnovation

RETScreen Plus - User Info

RETScreen® INTERNATIONAL

www.retscreen.net

- Roughly 175,000 users worldwide (40% of total RETScreen user base)
- NASA data made available in 36 languages covering 2/3rd world population, including throughout US and in developing countries
- Example of some users:
 - In the US, Ford Motor Company, High Construction Company, Weston Bakeries, Bell Labs and NASA (CASI work group)
 - Numerous other enterprise customers who manage multiple facilities (e.g. pension funds, government agencies, landlords, utilities, private developers, multinationals, hospitals, school boards, etc.)
 - Extensive number of International financial institutions and agencies (e.g. World Bank, United Nations, etc.) and organizations, and their clients, in developing countries
- Specific examples presented on following slides

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RETScreen Plus - Sampling of Newsletter Articles

RETScreen® INTERNATIONAL

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[Pennsylvania Firm Deploys Energy Management Software](#)

[NASA Using RETScreen Plus at Centres Across the United States](#)

[Energy Savings Opportunities Identified at Weston Foods Bakery](#)

[World Bank Supports Water & Sanitation Utility Energy Audits](#)

[Germany Promotes Building Energy Efficiency in Ukraine](#)

[Strengthening the Foundations of Clean Energy in West Africa](#)

[RETScreen Enables Brazilian Clean Energy Market](#)

[CER Chile Implements RETScreen Training Program](#)

[KIER uses RETScreen Plus for GSHP in South Korea](#)

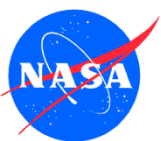
[Saudi Arabia Builds Clean Energy Capacity](#)

These articles available at:

<http://www.retscreen.net/ang/news.php>

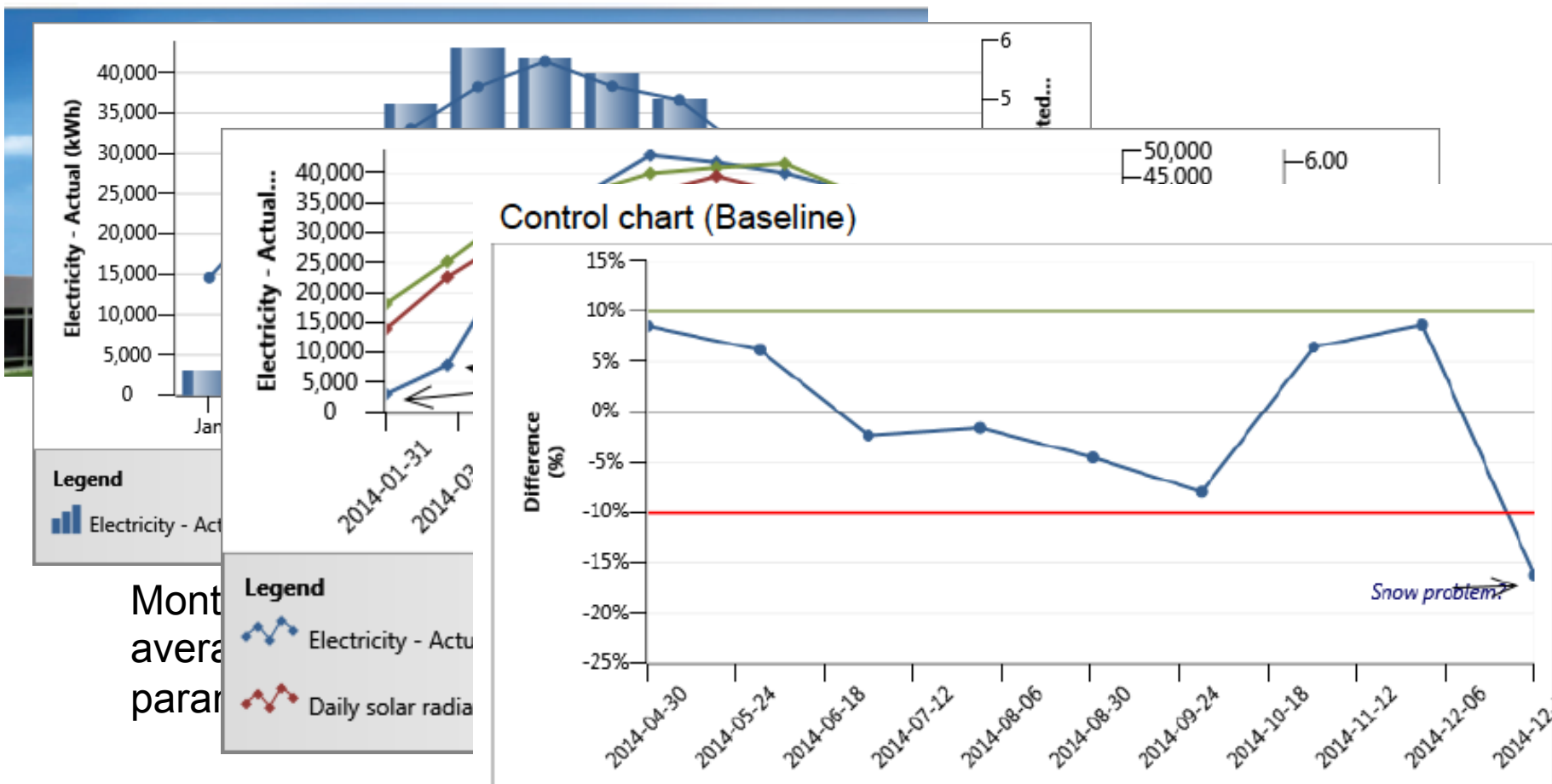
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RETScreen Example #1: Solar Power Plant

Ottawa Renewable Energy Cooperative
293 kW Solar Power Plant Facility (Ottawa, Ca)





RETScreen Example #2: GSHP System

Optimization of Ground Source Heat Pump (GSHP) System

“The Republic of Korea has implemented a RHO (renewable heat obligation) whereby public sector buildings larger than 10,000 m² must reduce their heating energy consumption by at least 11% between 2015-2030”.

Lee et al., 2014, Optimizing GSHP Performance with ICT and RETScreen Plus, *Journal of Energy and Power Engineering*, 8 (2014) 677-681.

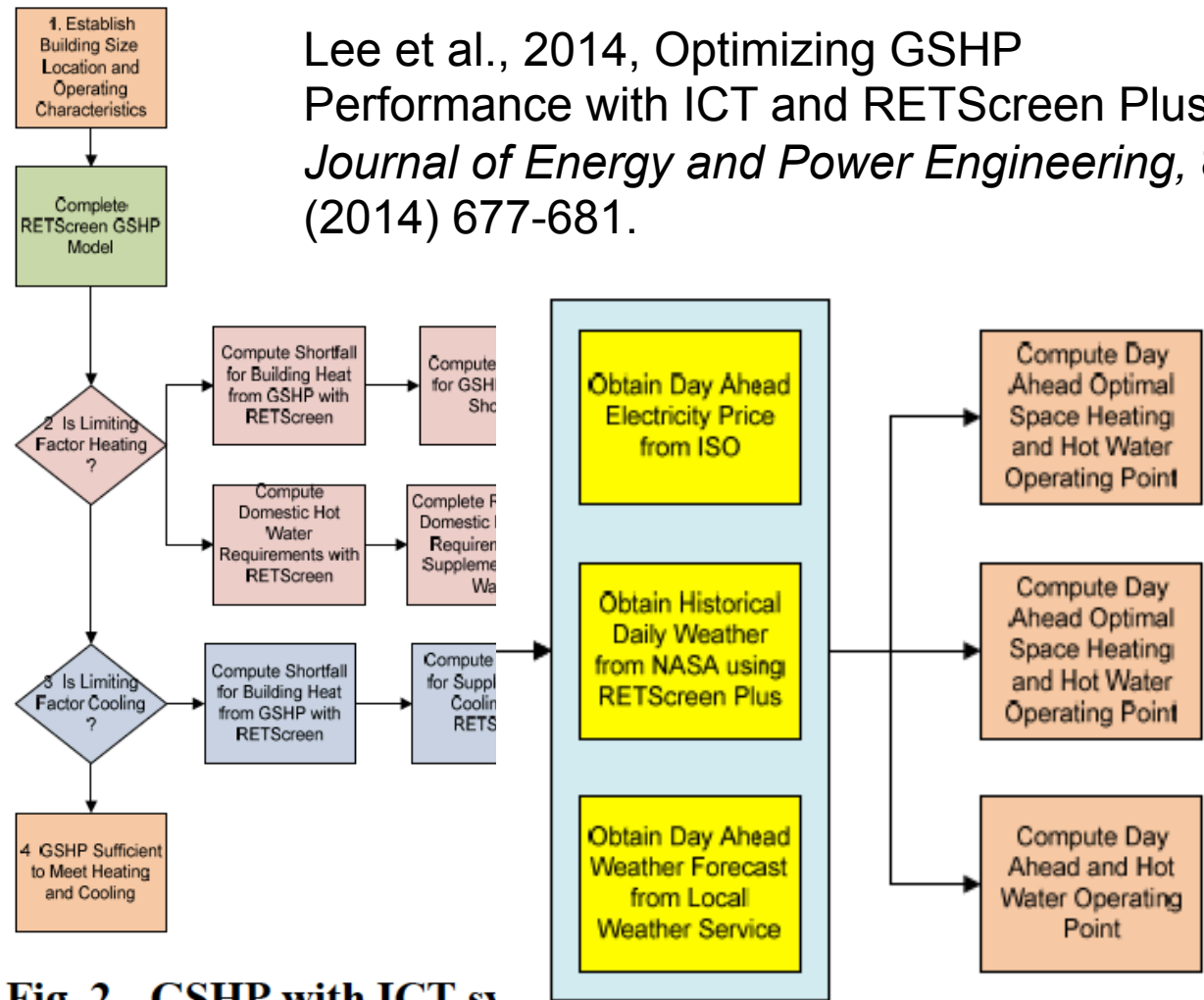
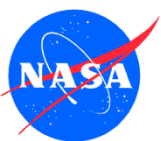


Fig. 2 GSHP with ICT system



RETScreen Example #2: GSHP System

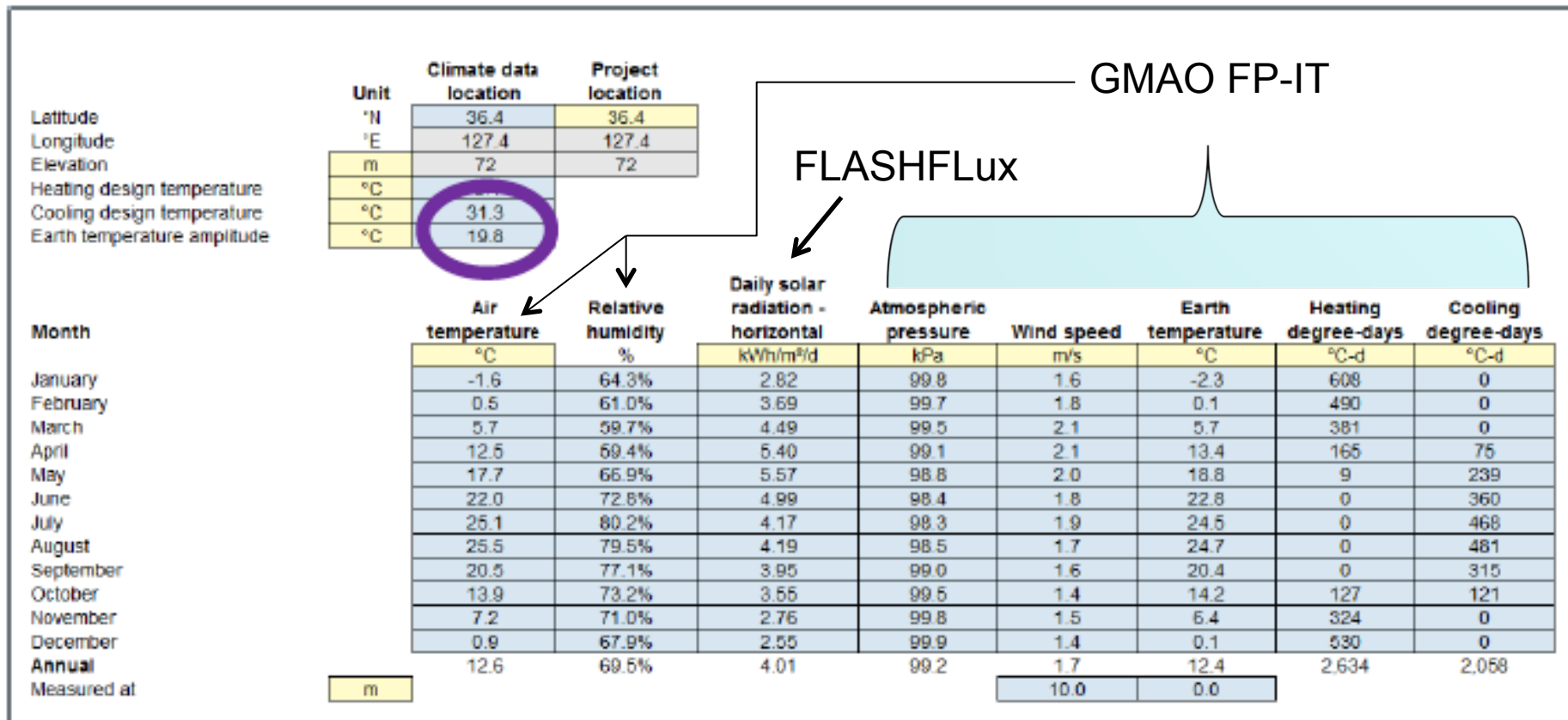
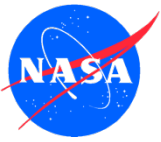


Fig. 3 Heating and cooling design temperatures for Daejeon, Korea.

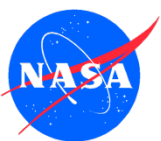


RETScreen Example #2: GSHP System

Concluding statement:

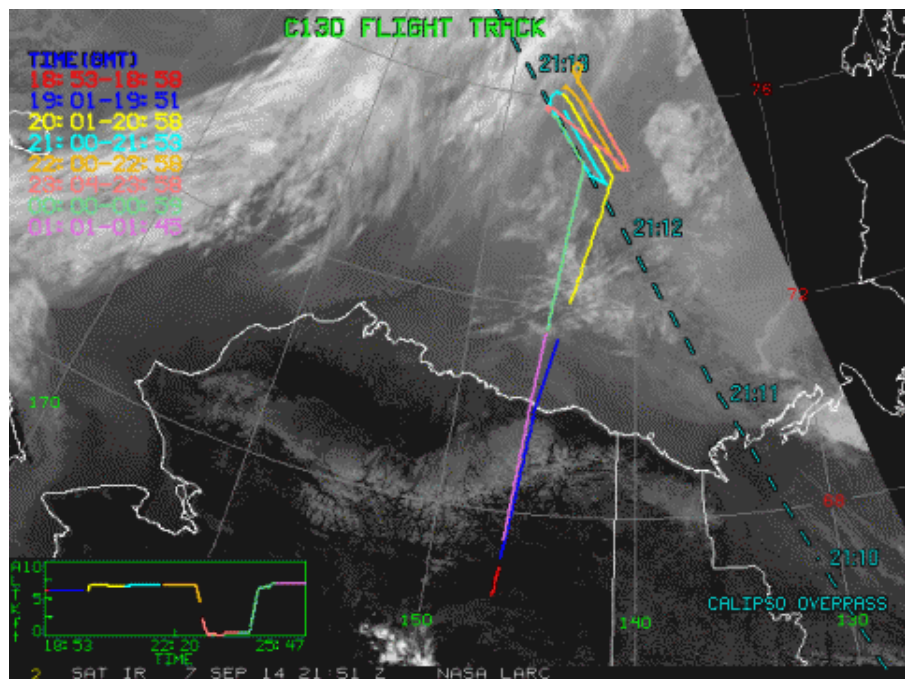
“The use of this methodology can assist Korea’s public sector to achieve the national goal of using a higher amount of energy from renewable sources and also reducing the carbon emission impact.”

Lee et al., 2014, Optimizing GSHP Performance with ICT and RETScreen Plus, *Journal of Energy and Power Engineering*, 8 (2014) 677-681.

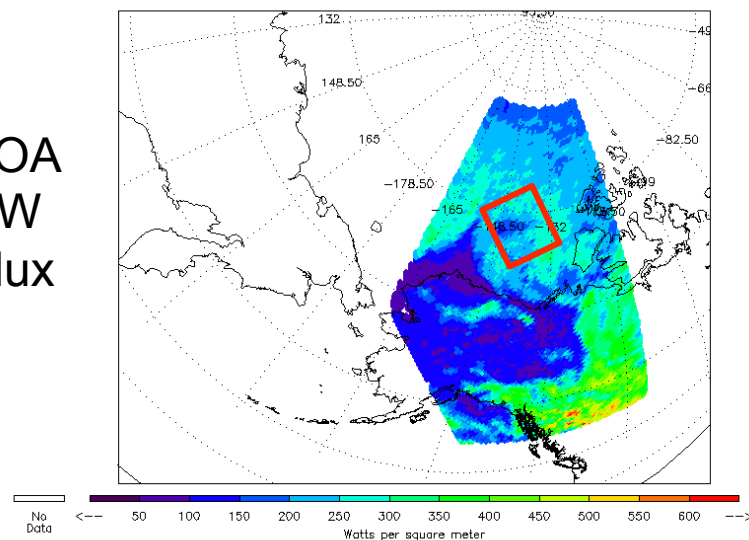


ARISE SSF Examples: Sept 7-8

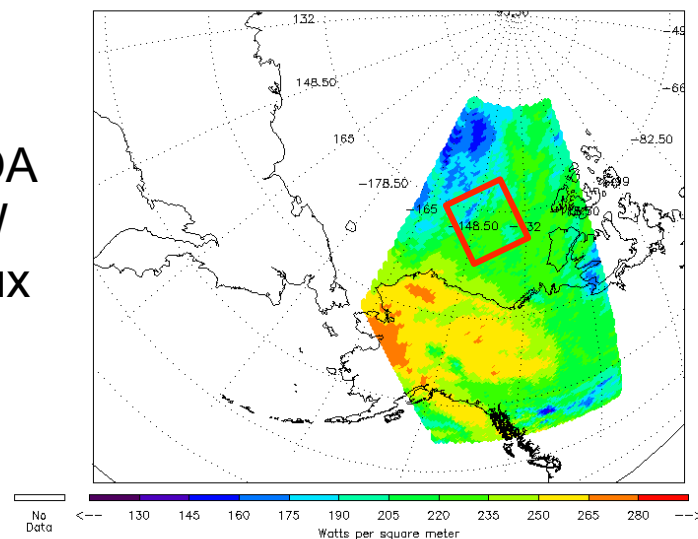
CERES Grid Box Flight Pattern



TOA
SW
Flux



TOA
LW
Flux

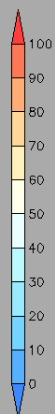
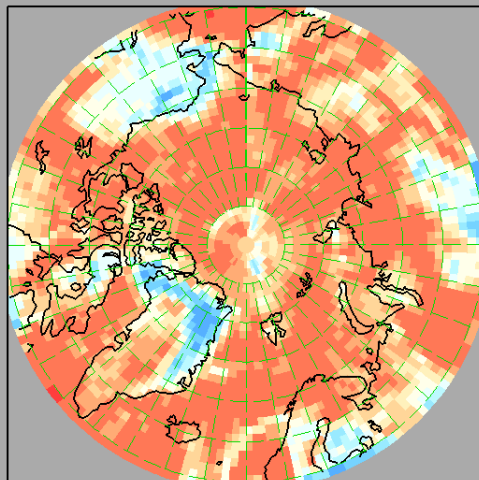




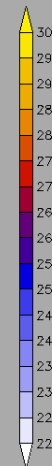
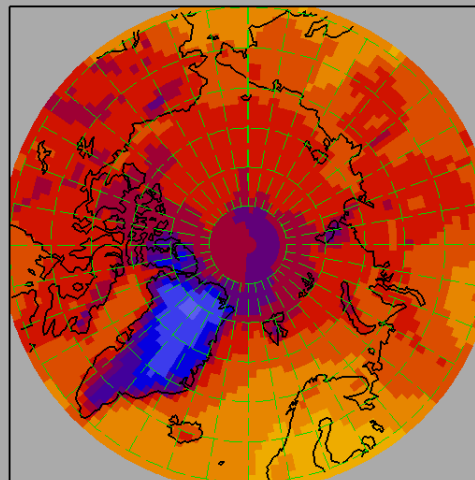
ARISE Daily Average: Sept 7, 2014

Cloud
Frac-
tion

FLASH TISA CLOUD %
07 SEP 2014

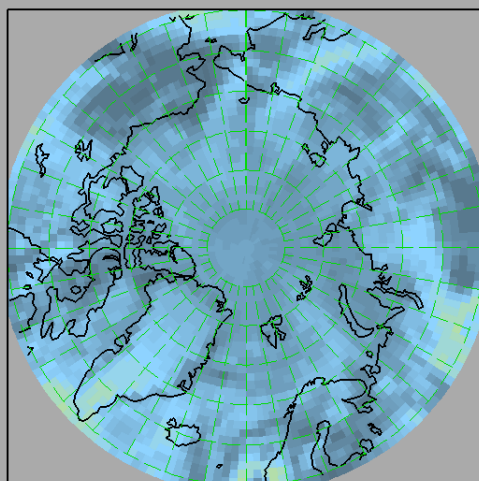


FLASH TISA Skin Temp (K)
07 SEP 2014

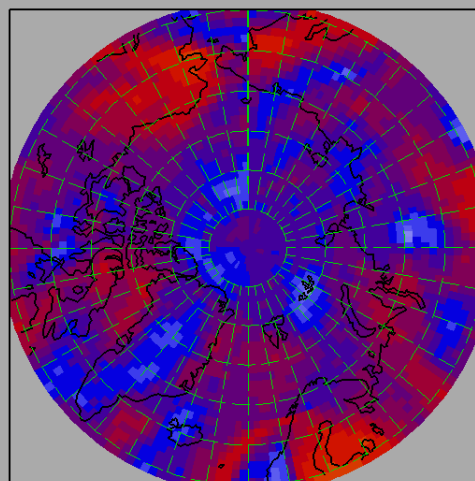


Skin
Temp-
erature

FLASH 3B TISA TOA SW
07 SEP 2014



FLASH 3B TISA TOA LW
07 SEP 2014



TOA
LW
Up

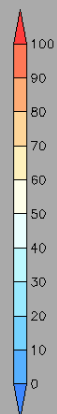
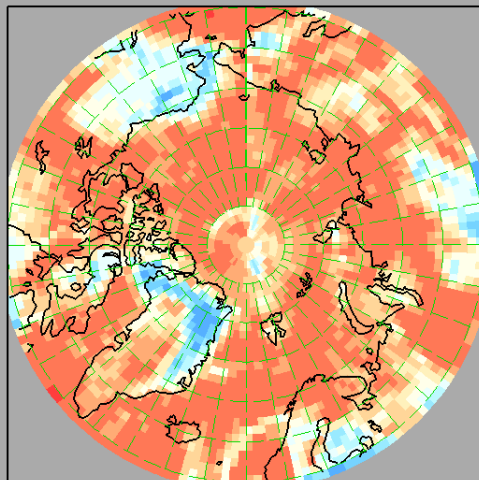
TOA
SW
Up



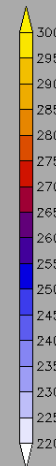
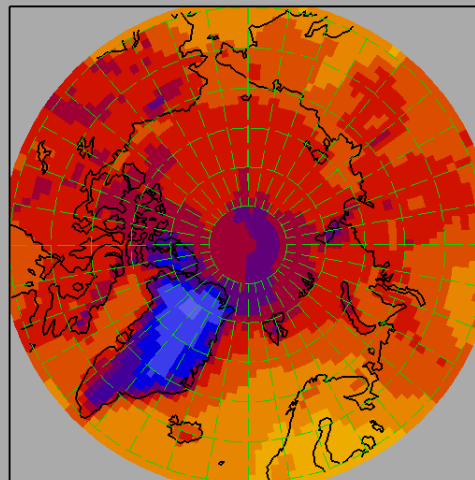
ARISE Daily Average: Sept 7, 2014

Cloud
Frac-
tion

FLASH TISA CLOUD %
07 SEP 2014

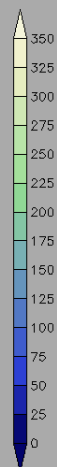
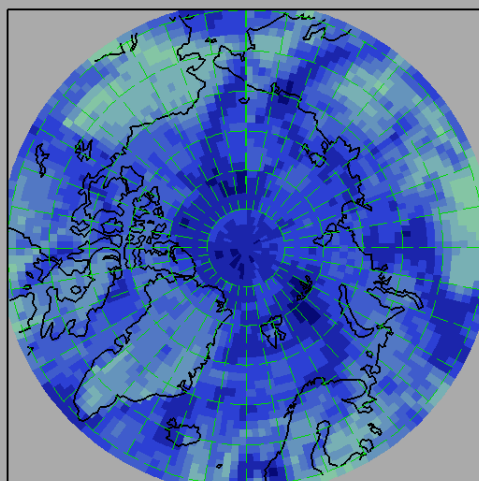


FLASH TISA Skin Temp (K)
07 SEP 2014



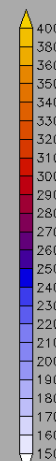
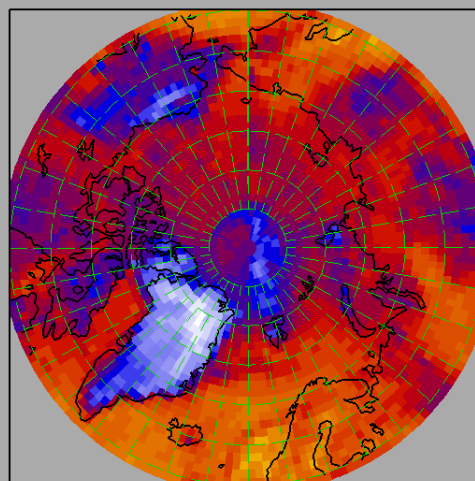
Skin
Temp-
erature

FLASH 3B TISA SFC SW DOWN
07 SEP 2014



Surf
SW
Down

FLASH TISA SFC LW DOWN
07 SEP 2014



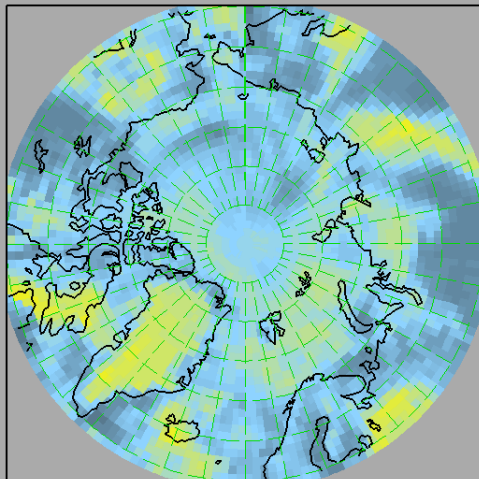
Surf
LW
Down



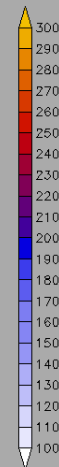
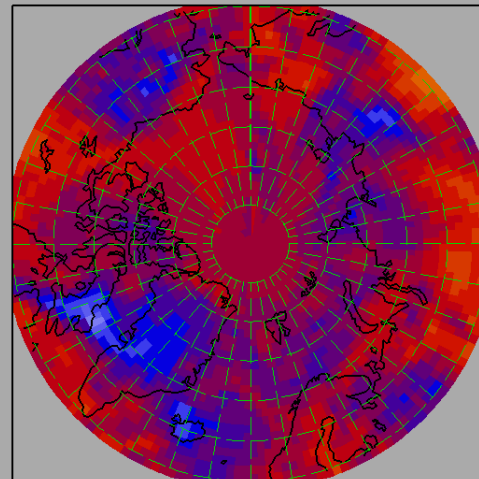
ARISE Daily Average Loops

TOA
SW
Up

FLASH 3B TISA TOA SW
15 AUG 2014

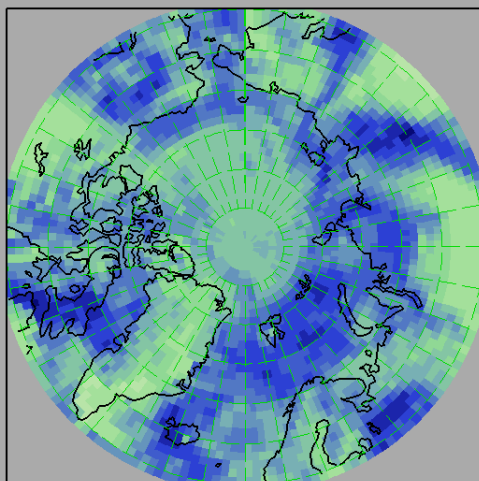


FLASH 3B TISA TOA LW
15 AUG 2014



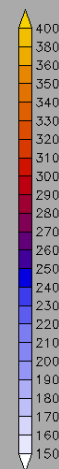
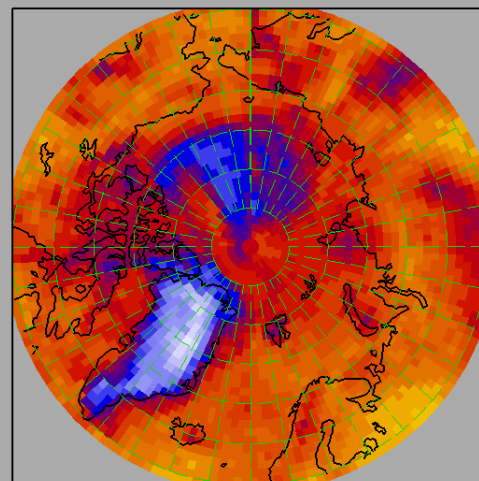
TOA
LW
Up

FLASH 3B TISA SFC SW DOWN
15 AUG 2014



Surf
SW
Down

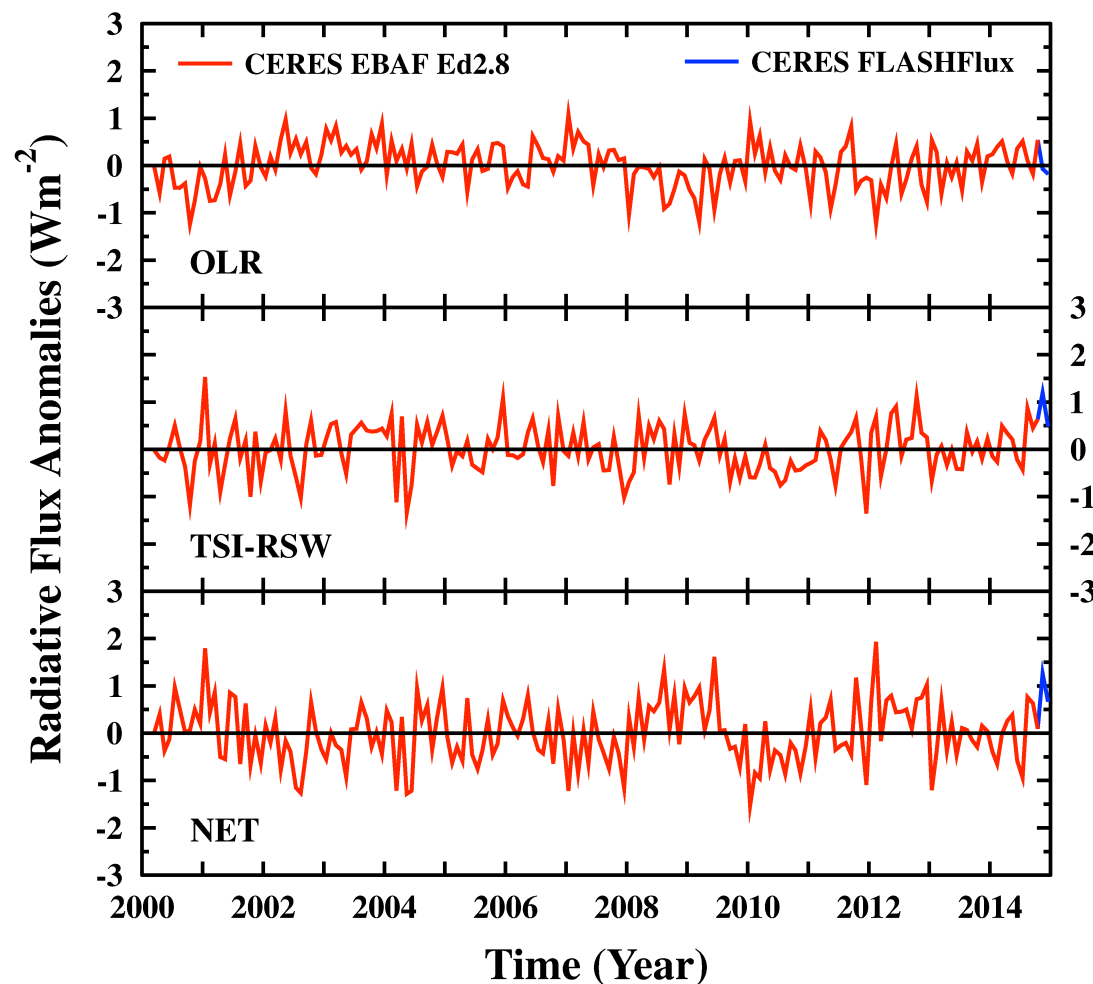
FLASH TISA SFC LW DOWN
15 AUG 2014



Surf
LW
Down



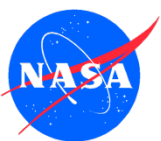
State of the Climate 2014: TOA Fluxes



- Global averaged TOA EBAF used to establish climatology
- FLASHFlux TOA fluxes normalized to EBAF to estimate last 3 months of 2014.

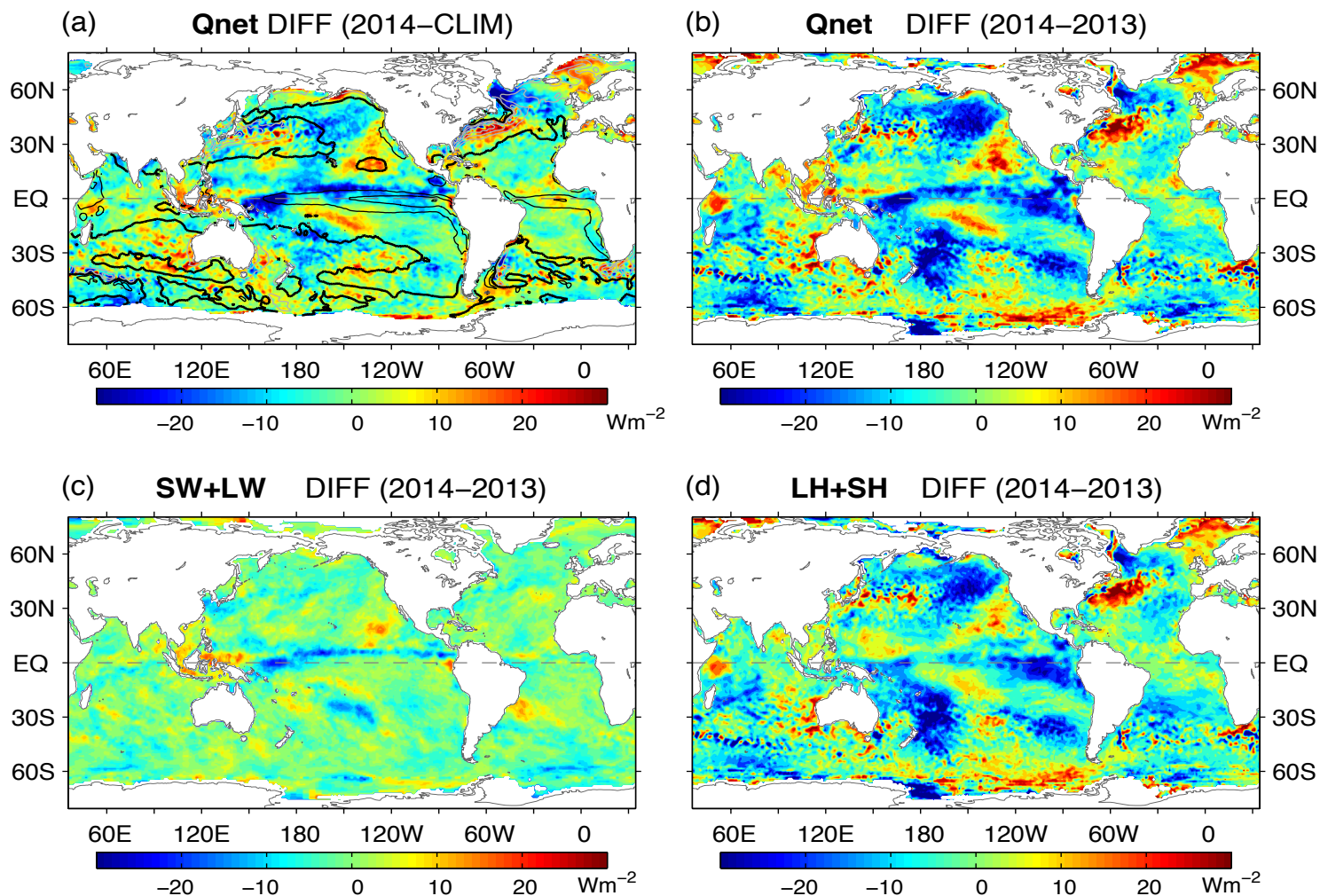
	One year change (2014 minus 2013) (Wm ⁻²)	2014 anomaly (relative to climate- logy) (Wm ⁻²)	Interannual variability (2001 to 2013) (Wm ⁻²)
OLR	+0.15	+0.15	±0.50
TSI	-0.05	+0.05	±0.20
RSW	-0.45	-0.25	±0.40
Net	+0.25	+0.15	±0.65

Wong *et al.*, submitted to BAMS State of the Climate



State of Climate 2014: Ocean Fluxes

- WHOI OAflux
Latent & Sensible
Heat fluxes
- Uses
FLASHFlux
year-to-year
difference for
radiative
fluxes
- Largest
change due
to shift in
Pacific ITCZ
& W of
Mexico

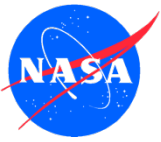


Yu, Lisan *et al.*, submitted to BAMS State of the Climate



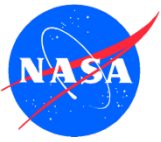
Summary and Conclusions

- ***FLASHFlux 3B***
 - Continuing production and validation for v3B; surface site and ARISE
 - Add TISA products to CERES subsetter
- ***Future Versions***
 - Must adapt MOA to accept FP-IT (v2) and evaluate use of aerosol
 - Will coordinate with Clouds and Inversion teams to adapt to Ed 4
 - Improving/upgrading algorithms will work with TISA team to increase similarity to current CERES products
 - Begin work on NPP SSF production system as new modules arrive
- ***FLASHFlux Applications:***
 - Continue improving transition process of data products via CERES subsetter and POWER
 - Developing GIS tools for POWER and with ASDC
- ***FLASHFlux publications:***
 - SSF published; TISA paper next (renewable energy journal?)
 - 2014 SotC reports submitted



FLASHFlux Web Sites:

<http://flashflux.larc.nasa.gov>



Backup Slides



Future Upgrades and Challenges

- ***Upgrade to Ed 4***
 - Revise FLASHFlux MOA to support CERES Ed 4 formats and now new version of FP-IT (samples available in June)
 - Obtain and adapt Clouds and Inversion for Ed 4 formats
 - Revise TISA to accommodate new inputs
 - Increase consistency with CERES TISA (work with TISA group)
 - produce netCDF formats and make available through subsetter
 - Develop FLASHFlux NPP SSF data product stream
- ***Continued refinement of algorithms:***
 - Coordinate new changes to SW Model B
 - Aerosols: evaluation FP-IT compared to “Fast-MATCH”
- ***Provide more visibility and accessibility to data***
 - Evaluate provision through new GIS web tools through ASDC

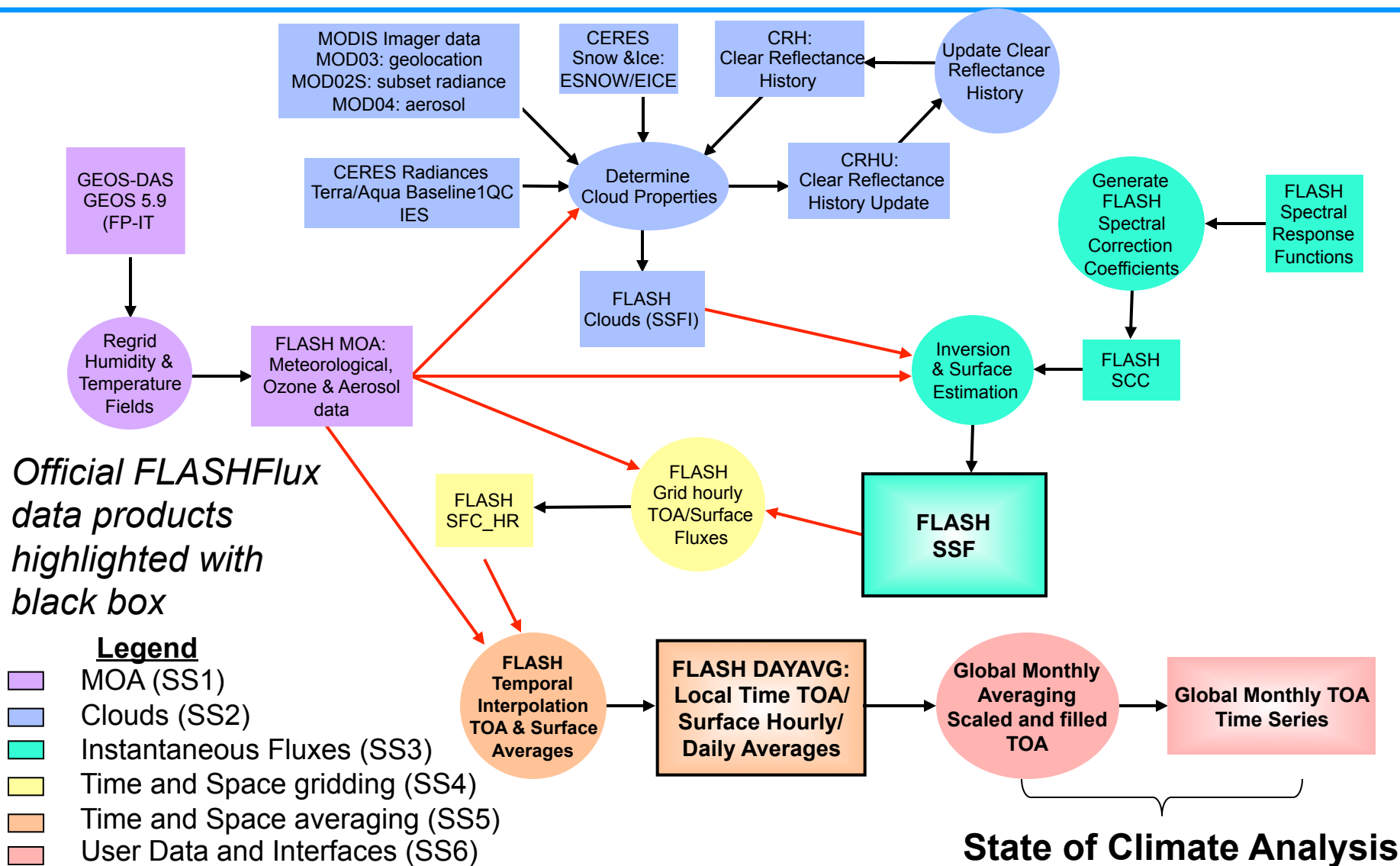


CERES FLASHFlux Overview

- ***FLASHFLUX = Fast Longwave And Shortwave Radiative Fluxes from CERES and MODIS***
- ***FLASHFlux Objectives:***
 - Provide TOA and surface radiative fluxes within one week of observation for scientific and applied science uses:
 - Level 2 – SSF for Terra and Aqua; currently through 4/19/14
 - Level 3 – TISA, Terra+Aqua, 1°x1°; currently through 4/16/14
 - Scientific, Educational and Applied Science use examples:
 - CloudSat and Megha-Tropiques (SSF)
 - Annual “State of the Climate” report on radiative budgets (TISA)
 - CERES S’COOL, NASA Earth Observatory (TISA)
 - LaRC POWER (TISA): Building energy monitoring through (RETScreen); Crop modeling systems such as APSIM (CSIRO)
 - Demonstrate processing system pushing data products to research and applications uses
 - Push subscription from ASDC to NASA Earth Observatory for Education
 - Pull from ASDC by CloudSat and Megha-Tropiques missions
 - Direct usage via DPO at NASA LaRC: CERES team, POWER



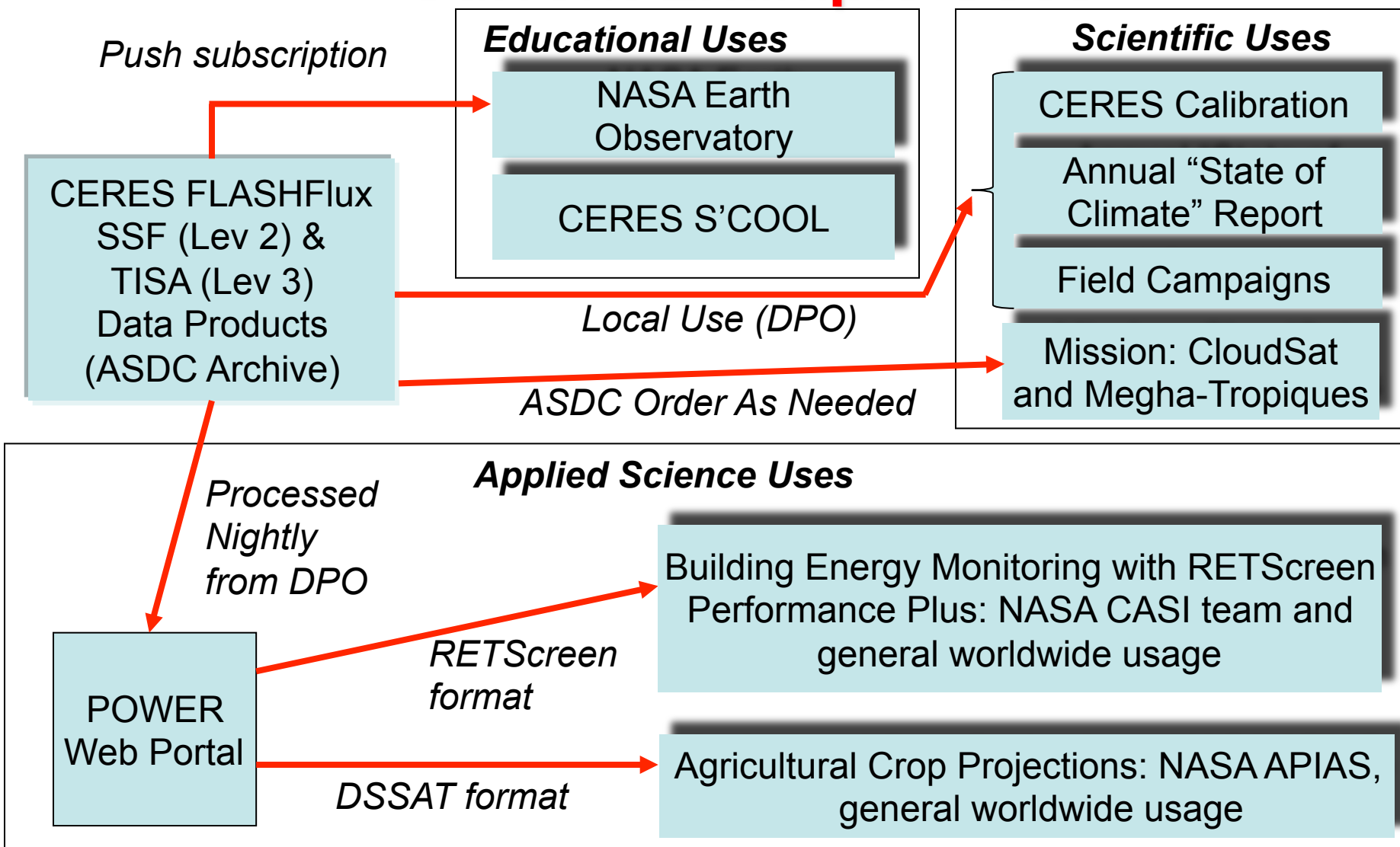
FLASHFlux Data Flow (v3A)



State of Climate Analysis



FLASHFLUX: Schematic Mapping to Current Example Uses





FLASHFlux TISA Data Products

**FLASHFlux TISA
Version 3A
Products
(Terra+Aqua;
Daily; 1°x1°
resolution;
Processed
through about
4/9/2014)**

**[https://
eosweb.larc.nas
a.gov/project/
ceres/flashflux-
tisa_table](https://eosweb.larc.nasa.gov/project/ceres/flashflux-tisa_table)**

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Processing, archiving and distributing Earth science data
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Maintenance Wednesday 4/23... details · CALIPSO Instrument OFF... details · Java Tool Unavailable... details

CERES Data and Information

The Clouds and the Earth's Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS) program. The CERES instruments provide radiometric measurements of the Earth's atmosphere from three broadband channels. The CERES missions are a follow-on to the successful Earth Radiation Budget Experiment (ERBE) mission. The first CERES instrument (PFM) was launched on November 27, 1997 as part of the Tropical Rainfall Measuring Mission (TRMM). Two CERES instruments (FM1 and FM2) were launched into polar orbit on board the EOS flagship Terra on December 18, 1999. Two additional CERES instruments (FM3 and FM4) were launched on board EOS Aqua on May 4, 2002. The newest CERES instrument (FM5) was launched on board the Suomi National Polar-orbiting Partnership (NPP) satellite on October 28, 2011.

Spring 2014 CERES Science Team Meeting April 22-24, 2014 at NASA Langley Research Center Hampton, VA

Announcements

New CERES EBAF-TOA Ed2.8 product
Mar 26 2014
The CERES team has made an update to the version of the Energy Balanced and Filled (EBAF) Top-of-Atmosphere (TOA) data product from Edition 2.7 to read the full announcement...

[View All](#)

[Level 3B](#) [Level 3](#) [Level 2](#) [Level 1B](#) [Documentation](#)

Spatially (1°x1° lat/lon regional, 1° zonal, global) and temporally (daily, monthly, etc.) averaged fluxes and clouds.

Processing Stream	Description	Data Products
SYN1deg	CERES temporally interpolated TOA fluxes (GEO-enhanced), MODIS and GEO clouds, and computed TOA/surface/profile fluxes.	• SYN1deg
SSF1deg	CERES temporally interpolated TOA fluxes (constant meteorology) and MODIS clouds.	• SSF1deg
ISCCP-D2like	CERES-MODIS and GEO cloud properties stratified by ISCCP cloud types and in the similar D2 format.	• ISCCP-D2like
FLASHFlux	Near real-time CERES observed TOA fluxes, MODIS clouds, and parameterized surface fluxes, not officially calibrated.	• FLASH_TISA
ERBElike	CERES instrument TOA fluxes using algorithms identical to those used by ERBE. - ES4: Also includes large-scale regional, zonal, and global fluxes - ES9: Also includes 2.5° regional instantaneous fluxes	• ES4 • ES9
CRS	Computed TOA/surface/profile fluxes using MODIS clouds and aerosols from SSF.	• FSW

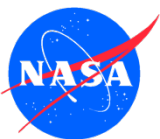


NASA Official: John M. Kusterer

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EOS
WORLD DATA SYSTEM




FLASHFlux SSF Data Products

FLASHFlux SSF Version 3A Products

Processed
through about
4/19/2014)

[https://
eosweb.larc.nas
a.gov/project/
ceres/flashflux-
l2_table](https://eosweb.larc.nasa.gov/project/ceres/flashflux-l2_table)

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[Level 3B](#) [Level 3](#) [Level 2](#) [Level 1B](#) [Documentation](#)

Instantaneous footprint-level (20km nominal) fluxes and cloud properties.

Processing Stream	Description	Data Products
SSF	CERES observed TOA fluxes, MODIS clouds and aerosols, and parameterized surface fluxes.	• SSF
CERES-MISR	MISR radiances associated with along-track CERES SSF data.	• CERES-MISR_MODIS
CCCM	CALIPSO/CloudSat cloud and aerosols collocated with nadir-view CERES fluxes and clouds.	• CCCM
FLASHFlux	Near real-time CERES observed TOA fluxes, MODIS clouds, and parameterized surface fluxes, not officially calibrated.	• FLASH_SSF
ERBElike	CERES instrument TOA fluxes using algorithms identical to those used by ERBE.	• ES8
CRS	Computed TOA/surface/profile fluxes using MODIS clouds and aerosols from SSF.	• CRS



- NASA Official: John M. Kusterer
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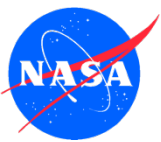


State of the Climate 2013 Analysis

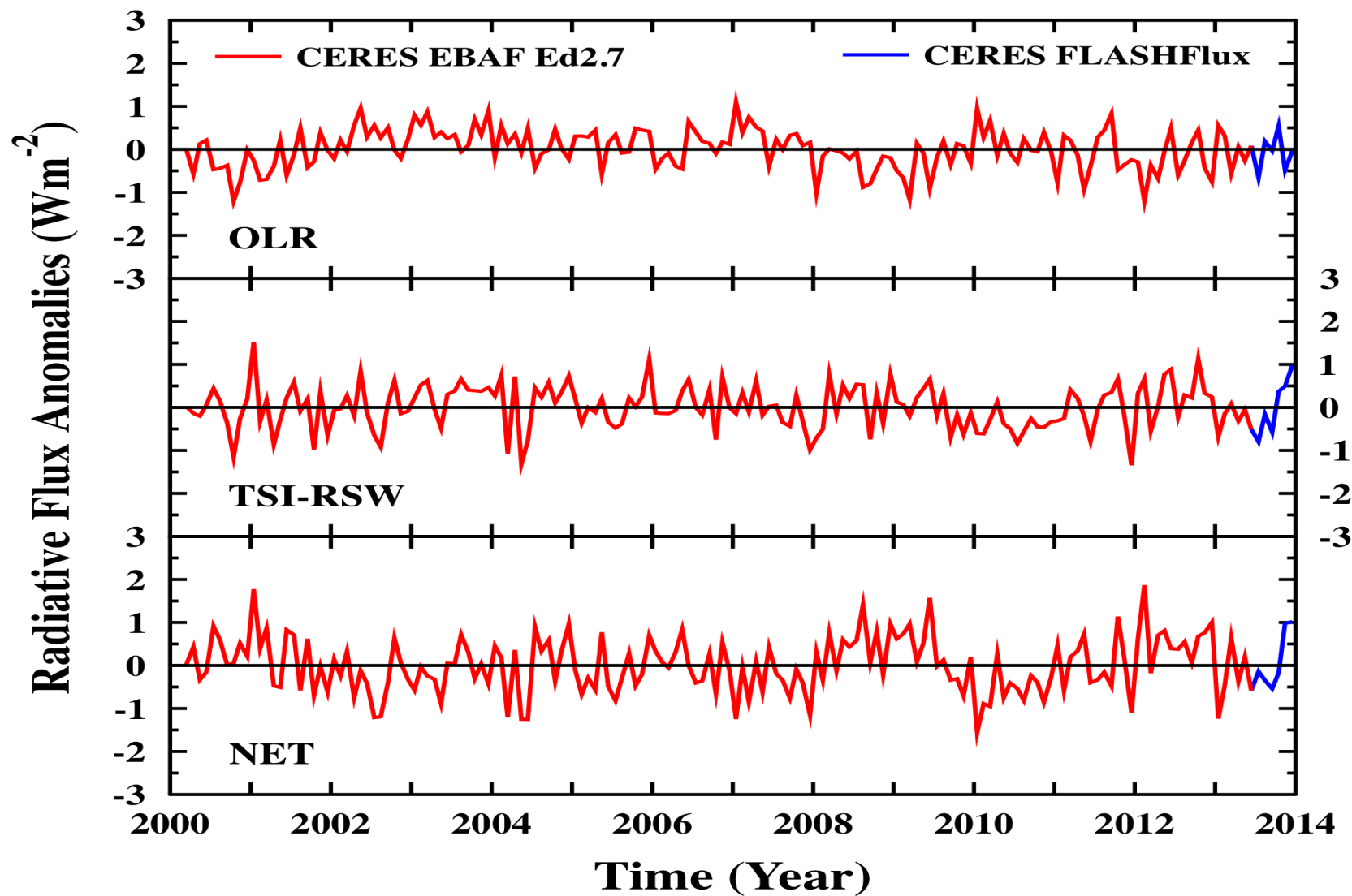
CERES FLASHFlux TOA flux variability for 2013 for BAMS “State of the Climate” report:

- TSI for SORCE had to be normalized relative to RMIB
- Overlap with EBAF from July 2012 to June 2013 used to adjust FLASHFlux TOA 3A fluxes
- 2σ monthly uncertainty (W m^{-2}) = ± 0.34 , ± 0.05 , ± 0.84 and $\pm 0.93 \text{ Wm}^{-2}$ for the OLR, TSI, RSW and NET radiation
- Global annual average anomalies and variability (in 2σ):

	One year change (2013 minus 2012) (Wm^{-2})	2013 anomaly (relative to climatology) (Wm^{-2})	Interannual variability (2001 to 2012) (Wm^{-2})
OLR	+0.25	-0.05	± 0.50
TSI	+0.00	+0.05	± 0.20
RSW	+0.45	+0.20	± 0.40
Net	-0.70	-0.10	± 0.70



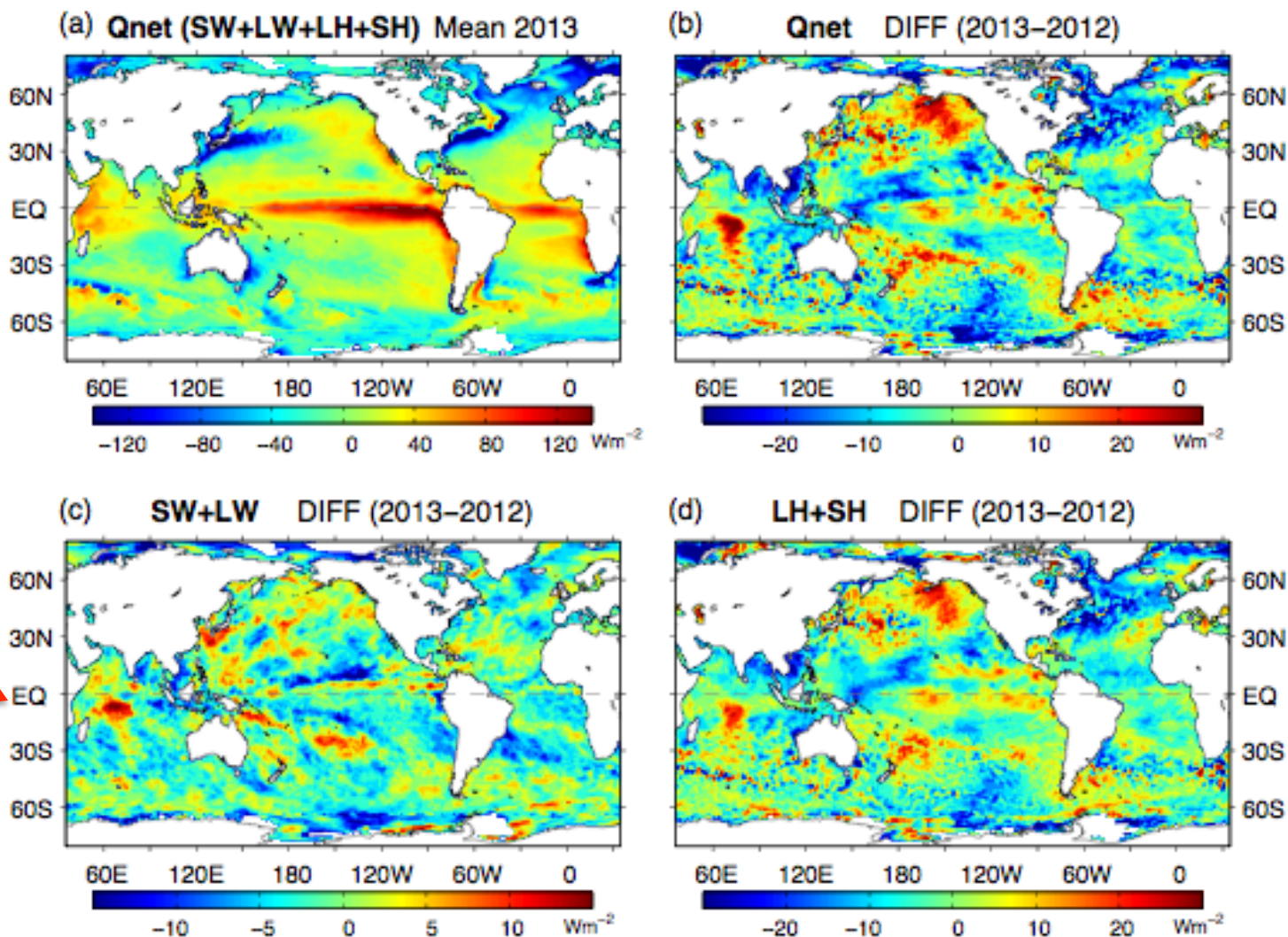
State of the Climate 2013 Analysis





Net Surface Flux Differences (2013-2012)

Lisan Yu
(WHOI),
OAFlux
With FLASH-
Flux net
surface flux
changes
2013-2012

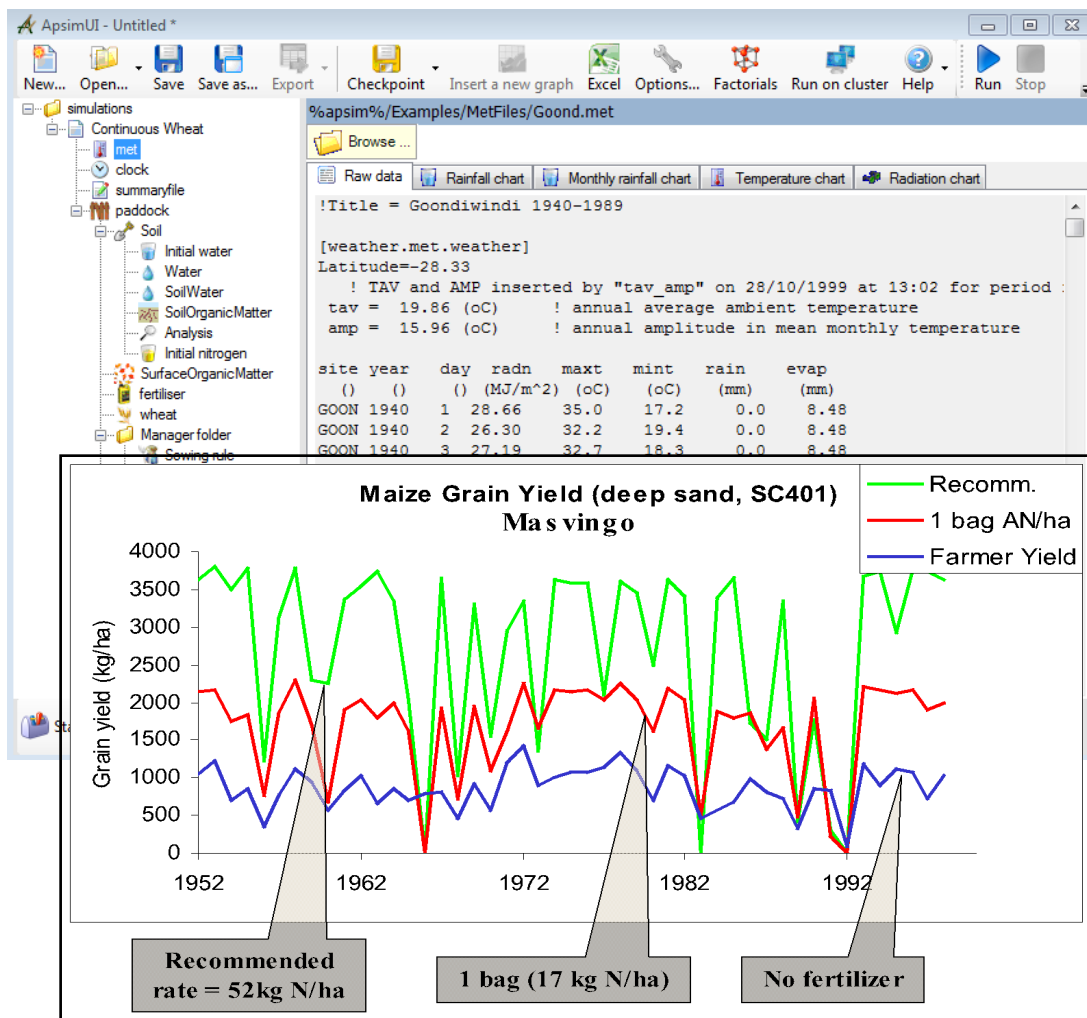




CERES FLASHFlux Agricultural Usage: CSIRO APSIM African Crop Modeling Project

APSIM (The Agricultural Production Systems sIMulator)

- internationally recognized as a highly advanced simulator of agricultural systems.
- DSSAT based formatted model
- Run for crop systems in West, East and Southern Africa
- FLASHFlux surface fluxes are “gold standard” of surface irradiance estimates for these regions (surface measurements are too poorly calibrated and/or maintained)
- Also uses surface temperature and other parameters from GEOS FP-IT



Results complements of John Hargreaves, CSIRO

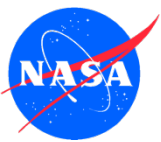


CERES FLASHFlux Energy Usage: RETScreen Performance Plus

RETScreen Performance Plus (imbedded in RETScreen Suite)

- Internationally recognized for monitoring, targeting and verification of clean energy technologies in operational building systems
- Special ASCII time series format used for SW + meteorological parameters from GEOS FP-IT
- RETScreen reports at least 20,000 users worldwide with most using the NASA data sets from FLASHFlux production
- Example usage includes Weston Bakeries (Wonder Bread), Ford Motor Company, Property management firms, government buildings (i.e., NASA), etc.





State of the Climate 2013 Published

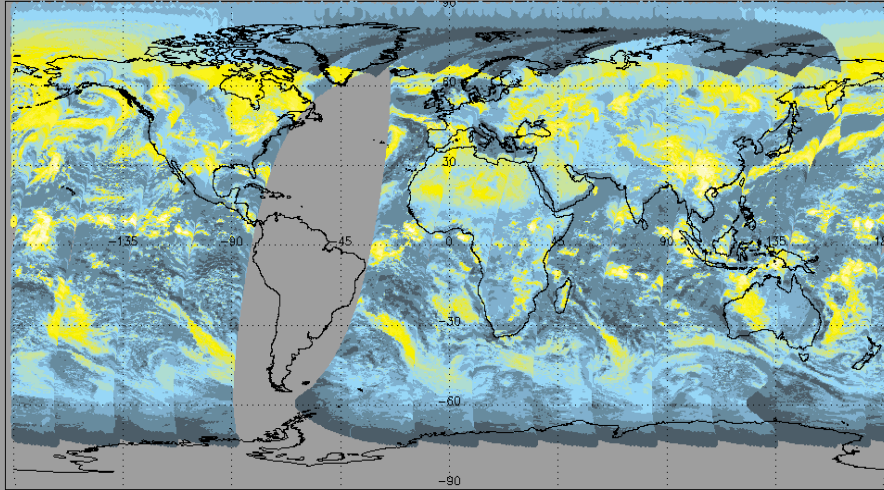


- *CERES FLASHFlux contributed to the special annual BAMS report on the “State of the Climate in 2013”.*
- *Issue appeared in Aug. 2014, providing estimates of changes in year to year Global Earth Radiation Budget for the first time.*
- *These data were extended and normalized relative to the CERES EBAF 2.7 products for this report.*



Recent Examples: SW

/data/FF/Version3B/Terra/2015/FLASH_SSF_Terra-FM1-MODIS_Version3B_112102.2015042200 Fri May 1 10:30:01 2015

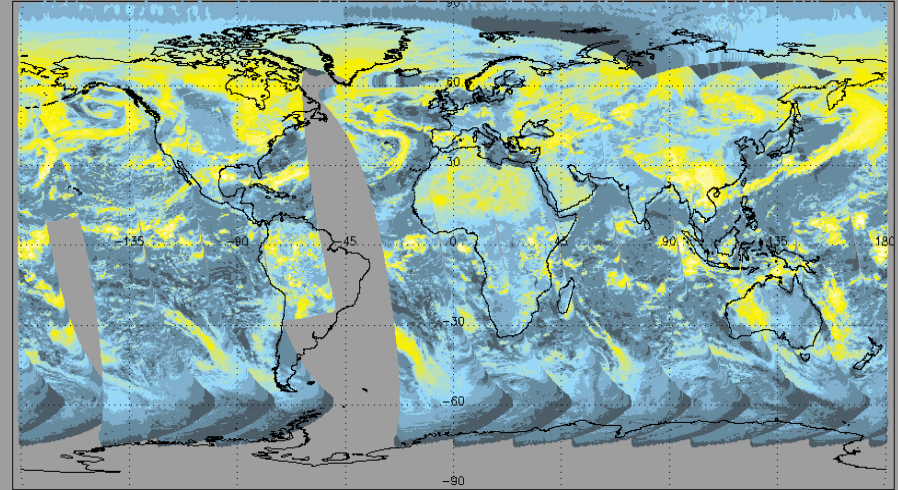


Watts per square meter

Criterion: 0.00000 <= CERES solar zenith at surface (Viewing Angles) <= 90.00000

Terra TOA SW

/data/FF/Version3B/Aqua/2015/FLASH_SSF_Aqua-FM3-MODIS_Version3B_112102.2015042200 Fri May 1 10:33:47 2015



Watts per square meter

Criterion: 0.00000 <= CERES solar zenith at surface (Viewing Angles) <= 90.00000

Aqua TOA SW